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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/522,174	01/24/2005	Masanobu Awano	264455US0PCT	3565

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EXAMINER	
TAI, XIUYU	
ART UNIT	**PAPER NUMBER**
1795	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/522,174	AWANO ET AL.	
	Examiner	Art Unit	
	Xiuyu Tai	1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 June 2009*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,5-8 and 10-52* is/are pending in the application.

4a) Of the above claim(s) *14-39* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1, 3, 5-8, 10-13, 40-52* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/23/2009 has been entered.

Response to Arguments

2. Applicant's arguments with respect to claim1, 3, 5-8, 10-13, and 40-52 have been considered but are moot in view of the new ground(s) of rejection necessitated by applicant's amendment.

3. In response to the arguments that the cell of Hibino requires operating temperature of 700 C and above (page1955, left col., second paragraph), it should be note that the cited section by applicant of Hibino regards the reactor shown in Figure 1 that was developed previously. The present developed reactor as shown in Figure 2 was operated in temperature between 550-900C (abstract; page 1956; Figure3).

4. In response to the arguments that Hibino does not teach "micro reaction regions", "micro reaction regions" are defined by applicants as the regions where chemical reactions take place and are located on the contacting points between the ion conduction phase and an electron conduction phase. The reactor of Hibino comprises two electrodes (a porous thin film of Pd, an electron conduction phase), and YSZ (an

ion conduction phase). As shown in Figure 2 of Hibino, the oxidation-reduction reactions take place at the microstructure of Pd electrodes (Figure 7) where Pd particles are extended to YSZ surfaces. Therefore, Hibino teaches "micro reaction regions" as claimed.

5. The articles that applicant indicated for submission (on page 14 and 15 of REMARKS filed on 6/23/2009) is not in file.

Claim Objections

6. Claims 13, 44, and 49 are objected to because of the following informalities: they depend on cancelled claim 9. Appropriate correction is required.

7. Claim 41 is objected to because of the following informalities: replace "oxidizing" with oxidation to be consistent with wording in claim 1. Appropriate correction is required.

Drawings

8. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "micro reaction regions" must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure

is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 1, 3, 5-8, 10-13, and 40-52 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

11. Claim 1 recites limitation “micro reaction regions” in line 7, defining that “micro reaction regions" are sites where reactions take place and they are also “a part of the chemical reaction part” to contacting points between the ion conduction phase and an electron conduction phase. It appears from the claim language the "micro reaction regions” may be interpreted as regions where the chemical reactions take place at the contacting points between the ion conduction phase and an electron conduction phase.

Thus, “micro reaction regions” seem located at the interfaces between cathode/oxygen ion conductor and anode/oxygen ion conductor. However, claim 1 in line 18 recites limitation “the micro reaction regions” that is incorporated with a working electrode layer. Since the working electrode is “formed in the upper part of the cathode” as claimed (no interfaces between cathode/oxygen ion conductor and anode/oxygen ion conductor), It appears that there is no contacting points between the ion conduction phase and an electron conduction phase; hence no “micro reaction regions” as defined in line 7 (part (1)) of claim 1 in the working electrode layer. In addition, “the micro reaction regions” in line 18 also requires "nanometers to a micrometer in size" while "micro reaction regions" do not have this limitation. It is not clear if “micro reaction regions” in line 7 is the same as “the micro reaction region” in line 18. Appropriate correction/clarification is required.

12. Claim 1 recites limitation “a working electrode layer to manage oxidation-reduction reactions”. Since the working electrode is “formed in the upper part of the cathode” as claimed and the cathode is a reduction phase (line 4 of claim 1) where only reduction reaction takes place, it is not clear how the working electrode layer on the top of the cathode manages oxidation-reduction reactions as claimed. Appropriate correction/clarification is required.

13. Claim 1 recites limitation “the space” in the amended part. There is insufficient antecedent basis for this limitation in the claim.

14. Claims 3, 5-8, 10-13, and 40-52 are rejected because of their dependency to the parent claim.

Claim Rejections - 35 USC § 103

15. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

16. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

17. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

18. Claims 1, 3, 5-8, 10-12, 40-43, and 45-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hibino ("Medium-temperature electrolysis of NO and CH4 under lean-burn conditions using Ytria-stabilized Zirconia as a Solid Electrolyte",

J.CHEM. SOC. FARADAY TRANS., 91(13), 1955-1959, 1995) in evidence of Arai et al (U.S. 6,322,910) and further in view Cretzmeyer et al (U.S. 4,189,526).

19. Regarding claim 1, Hibino et al disclose a single-compartment reactor. The reactor comprises: (1) a solid electrolyte YSZ as an oxygen ion conductor (Figure 1; page 1953); and (2) two Pd electrodes in the form of porous film as cathode and anode (Figure 1; page 1956). The reactions take place at cathode and anode depending on exhaust gases introduced into the reactor while a current is applied between cathode and anode (Figure 1; page 1955). The operating temperature of the reactor is in the range of 550-900C (abstract; page 1956; Figure3).

As shown in Figure 7, microstructure of Pd electrodes (page 1957) has fractured surface images (page 1958). Since the thickness of plated Pd electrode is about 4um (page 1958), the Pd electrode may contain multiple mono-layered Pd particles. The layer that is remote from the YSZ surface may be served as a working electrode layer while the layer that is contacted with YSZ surface may be referred as a cathode, thus the microstructure (i.e. micro reaction regions) of Pd electrodes is extended from the YSZ surface to the outmost surface of the electrode (Figure 2 & Figure 7). Hibino also teaches that the performance of the reactor depends on the morphology and thickness of the Pd electrode (abstract; page 1958 & 1959).

The microstructure of Pd electrode includes interfaces having Pd particles (i.e. a metal phase of the electron conduction phase) and the gaps between Pd particles (i.e. micro spaces). Hinibo is silent about an oxygen deficient layer. However, Arai et al disclose an organic electroluminescent device. Arai teaches that an oxygen-deficient

layer is formed under oxygen-lacking condition (with no addition of oxygen, oxygen content of 60%-90%) while an oxide layer is formed under oxygen-rich environment (with the addition of oxygen, col. 4, line 55-65). Pd electrode of Hibino is attached to YSZ by electroless plating method in a mixed solution of 0.5% PdCl2 and 6% N2H4.2HCL at 90C (page 1956 of Hibino), which is under oxygen-lacking conditions (i.e. in an aqueous solution at higher temperature). Therefore, an oxygen-deficient layer is inherently formed at the boundaries of Pd electrode and YSZ from HIbino's method as is evident by the teaching of Arai.

Hibino fail to teach a barrier layer on the microstructure of Pd electrode. However, Cretzmeyer et al disclose a metal/oxygen cell having an oxygen diffusivity-limiting membrane 22 onto the cathode 24 (Figure 1; col. 3, line 25-30) in order to provide optimum active life for the cell (col. 2, line 49-52; col. 4, line 1-5). The membrane 22 may be formed of a polymer such as polytetrafluoroethylene (col. 3, line 25-27), which is less electron conductive. Therefore, it would be obvious for one having ordinary skill in the art to include a membrane as suggested by Cretzmeyer in the device of Hibino in order to protect the cell for prolonged active life.

20. Regarding claim 3, Hibino teaches that the microstructure (i.e. micro reaction regions) of Pd electrodes is extended from the YSZ surface to the outmost surface of the electrode (Figure 2 & Figure 7) and electrolysis of NOx and CH4 take place at Pd electrodes (page 1956).

21. Regarding claim 5, the reaction on the Pd cathode of Hibino is the reduction of NO to N2 achieved by using YSZ as solid electrolyte (page 1955), reads on the instant claim.

22. Regarding claim 6, Figure 7 of Hibino shows that Pd electrode contains particles (page 1958).and oxidation-reduction reactions take place by applying dc current to electrodes (Figure 2; page 1955).

23. Regarding claim 7, as taught by Hibino, the boundaries between YSZ and cathode/anode electrode have a metal phase of Pd electrode and some gap due to the presence of small particle grains. Hinibo is silent about an oxygen deficient layer. However, Arai et al disclose an organic electroluminescent device. Arai teaches that an oxygen-deficient layer is formed under oxygen-lacking condition (with no addition of oxygen, oxygen content of 60%-90%) while an oxide layer is formed under oxygen-rich environment (with the addition of oxygen, col. 4, line 55-65). Pd electrode of Hibino is attached to YSZ by electroless plating method in a mixed solution of 0.5% PdCl2 and 6% N2H4.2HCL at 90C (page 1956 of Hibino), which is under oxygen-lacking conditions (i.e. in an aqueous solution at higher temperature). Therefore, an oxygen-deficient layer is inherently formed at the boundaries of Pd electrode and YSZ from HIbino's method as is evident by the teaching of Arai

24. Regarding claim 8, the single compartment reactor of Hibino has a structure that YSZ as an ion conductor contacts with Pd cathode and Pd anode (Figure 1; page 1956) and the microstructure of Pd electrode is extended cross the electrode (Figure 2 & 7), reads on the instant claim.

25. Regarding claim 10, the reaction on the cathode of Hibino is the reduction of NO to N2 that is a conversion reaction of matter (NO to N2; page 1955; Figure 1), reads on the instant claim.

26. Regarding claim 11, the exhaust gas introduced into the cathode of Hibino is NO (Figure 1; page 1955), reads on the instant claim.

27. Regarding claim 12, the reaction on the cathode of Hibino is the reduction of NO to N2 (page 1955; Figure 1), reads on the instant claim.

28. Regarding claim 13, the reaction of Hibino is carried out in the presence of oxygen and metal (page 1956); hence chemical reactions take place as claimed.

29. Regarding claim 40, the solid electrolyte YSZ of Hibino is an oxygen ion conductor (Figure 1; page 1953), reads on the instant claim.

30. Regarding claims 41 and 47, Hibino teaches that reduction and oxidation reactions take place at the interface of two palladium electrode in the form of porous film (Figure 1; page 1955), reads on the instant claims.

31. Regarding claim 42, two Pd electrodes of Hibino (i.e. electrically conductive substance) in the form of porous film as cathode and anode (Figure 1; page 1956), reads on the instant claim.

32. Regarding claim 43, the solid electrolyte YSZ of Hibino is Ytria-stablized zirconia (i.e. zirconia stabilized with ytria), reads on the instant claim.

33. Regarding claim 44, the membrane of Cretzmeyer may be formed of a polymer such as polytetrafluoroethylene (col. 3, line 25-27), which is an insulator.

34. Regarding claim 45, Hibino carries out the experiment by electrolyzing NO (page 1956), reads on the instant claim.

35. Regarding claim 46, Hibino/Cretzmeyer is silent about the shape of the reactor. However, one having ordinary skill in the art would have realized to construct proper shape of the reactor in order to accommodate the intended use and/or user's preference.

36. Regarding claim 48, since the solid electrolyte is an oxygen ion conductor (Figure 1; page 1953), it is inherent to have the same characteristics as claimed.

37. Regarding claim 49, the solid electrolyte of Hibino is Ytria-stablized zirconia (comprising zirconia, ZrO2), reads on the instant claim.

38. Regarding claim 50, the current density of Hibino is in a range of 0-800 mA/cm2 (Figure 3) and the surface area of each electrode is about 0.5 cm2 (page 1956), resulting in the applied current being in a rage of 0-400 mA. The voltage is in a range of 0-6 V (Figure 4).

39. Regarding claim 51, Hibino indicates that the performance of the reactor can be improved by decreasing the thickness of the Pd electrode film and Pd particle sizes (page 1958) and preparing thin YSZ film (page 1959). Therefore, one having ordinary skill in the art would have realized to optimize the configuration of electrode or YSZ in order to increase NO conversion efficiency.

40. Regarding claim 52, the operating temperature of the reactor is in the range of 550-900C (abstract; page 1956; Figure3 of HIbino).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Xiuyu Tai whose telephone number is 571-270-1855. The examiner can normally be reached on Monday - Friday, 7:30 AM - 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jennifer Michener can be reached on 571-272-1424. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/X. T./
Examiner, Art Unit 1795
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